

AD-A187 786

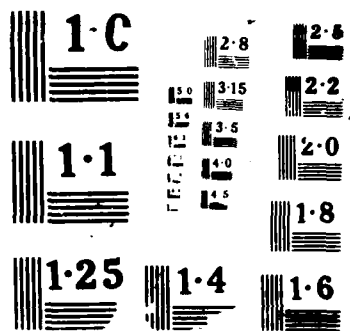
COUNTER-BALANCED PENDULUM(U) AIR FORCE WRIGHT
AERONAUTICAL LABS WRIGHT-PATTERSON AFB OH J LEE MAY 86
AFMAL-TR-86-3814

1/1

UNCLASSIFIED

F/G 20/11.5 NL



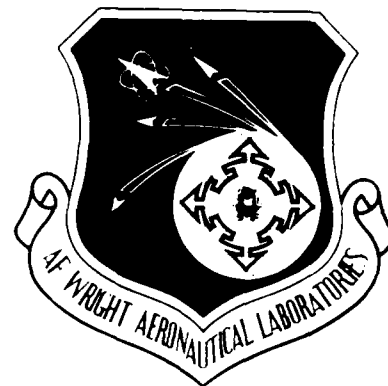


AFWAL-TR-86-3014

COUNTER-BALANCED PENDULUM

Con Lee

Structural Vibration Branch
Structures and Dynamics Division



AD-A187 706

May 1986

Final Report for Period December 1985 - January 1986

Approved for public release; distribution is unlimited.

DTIC
ELECTE
JAN 05 1988
S D

FLIGHT DYNAMICS LABORATORY
AIR FORCE WRIGHT AERONAUTICAL LABORATORIES
AIR FORCE SYSTEMS COMMAND
WRIGHT-PATTERSON AIR FORCE BASE, OHIO 45433-6553

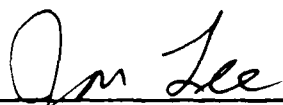
07 12 14 125

NOTICE

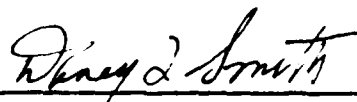
When Government drawings, specifications, or other data are used for any purpose other than in connection with a definitely related Government procurement operation, the United States Government thereby incurs no responsibility nor any obligation whatsoever; and the fact that the government may have formulated, furnished, or in any way supplied the said drawings, specifications, or other data, is not to be regarded by implication or otherwise as in any manner licensing the holder or any other person or corporation, or conveying any rights or permission to manufacture use, or sell any patented invention that may in any way be related thereto.

This report has been reviewed by the Office of Public Affairs (ASD/PA) and is releasable to the National Technical Information Service (NTIS). At NTIS, it will be available to the general public, including foreign nations.

This technical report has been reviewed and is approved for publication.

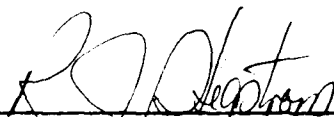


JON LEE
Project Engineer



DAVEY L. SMITH, Chief
Vibration & Acoustics Branch
Structures & Dynamics Division

FOR THE COMMANDER



ROGER J. HEGSTROM, Colonel, USAF
Chief, Structures and Dynamics Division

If your address has changed, if you wish to be removed from our mailing list, or if the addressee is no longer employed by your organization please notify AFWAL/FIBG _____, Wright-Patterson AFB OH 45433- 6553 _____ to help maintain a current mailing list.

Copies of this report should not be returned unless return is required by security considerations, contractual obligations, or notice on a specific document.

Unclassified

SECURITY CLASSIFICATION OF THIS PAGE

REPORT DOCUMENTATION PAGE

1a. REPORT SECURITY CLASSIFICATION Unclassified		1b. RESTRICTIVE MARKINGS AD-A187 706	
2a. SECURITY CLASSIFICATION AUTHORITY		3. DISTRIBUTION/AVAILABILITY OF REPORT Approved for public release; distribution is unlimited.	
2b. DECLASSIFICATION/DOWNGRADING SCHEDULE			
4. PERFORMING ORGANIZATION REPORT NUMBER(S) AFWAL-TR-86-3014		5. MONITORING ORGANIZATION REPORT NUMBER(S)	
6a. NAME OF PERFORMING ORGANIZATION Structural Vibration Branch	6b. OFFICE SYMBOL (If applicable) AFWAL/FIBG	7a. NAME OF MONITORING ORGANIZATION	
6c. ADDRESS (City, State and ZIP Code) AFWAL/FIBG Wright-Patterson AFB, OH 45433-6553		7b. ADDRESS (City, State and ZIP Code)	
8a. NAME OF FUNDING/SPONSORING ORGANIZATION AFOSR/NM	8b. OFFICE SYMBOL (If applicable)	9. PROCUREMENT INSTRUMENT IDENTIFICATION NUMBER	
8c. ADDRESS (City, State and ZIP Code) AFOSR/NM Bolling AFB, Washington, DC 20332		10. SOURCE OF FUNDING NOS.	
11. TITLE (Include security classification) Counter-Balanced Pendulum		PROGRAM ELEMENT NO. 61102F	PROJECT NO. 2304
12. PERSONAL AUTHOR(S) Jon Lee		TASK NO. N1	WORK UNIT NO. 13
13a. TYPE OF REPORT Final	13b. TIME COVERED FROM Dec 85 TO Jan 86	14. DATE OF REPORT (Yr., Mo., Day) 1986, May	15. PAGE COUNT 8
16. SUPPLEMENTARY NOTATION This TR diskette is runnable on a Z-100 desktop computer.			
17. DESCRIPTORS		18. SUBJECT TERMS (Continue on reverse if necessary and identify by block number)	
FIELD	GROUP	SUB. GR.	
20	11		
		Counterbalanced pendulum, Zero-g simulation, Time-integration, on Z-400 microcomputer.	
19. ABSTRACT (Continue on reverse if necessary and identify by block number) To simulate zero-gravity in ground-testing, one may analyze a system of counter-balanced pendulums made up of two identical bobs which are tied to the ends of an inextensible string and are suspended from two pulleys separated by a certain distance. With this diskette you will explore the dynamics of counter-balanced pendulums when only one bob is swung, while the other is allowed to move vertically. There are two basic modules. One is the in-situ integration by the fourth-order Runge-Kutta scheme with a tolerance check. Although there is a restriction on the choice of initial angles, you may integrate the motion as long as you please. The other module is a theoretical analysis for small and large times to deduce qualitative dynamical behavior. We have discovered an asymptotic invariant of motion which is defined analogous to the action of standard pendulum.			
20. DISTRIBUTION/AVAILABILITY OF ABSTRACT UNCLASSIFIED/UNLIMITED <input checked="" type="checkbox"/> SAME AS RPT <input type="checkbox"/> OTIC USERS <input type="checkbox"/>		21. ABSTRACT SECURITY CLASSIFICATION Unclassified	
22a. NAME OF RESPONSIBLE INDIVIDUAL Jon Lee		22b. TELEPHONE NUMBER (Include Area Code) (513) 255-3220	22c. OFFICE SYMBOL AFWAL/FIBG

FOREWORD

This diskette was prepared in the Structural Vibration Branch, Structures & Dynamics Division, Flight Dynamics Laboratory, AF Wright Aeronautical Laboratories, Wright-Patterson AFB, OH 45433. The work reported herein was performed under the work unit 2304N113, Nonlinear Dynamics, during the period of December 1985 to January 1986.

To the best of our knowledge, the presentation of a TR in the form of software that one can run on a Z-100 desktop computer has never been attempted. Although a TR is traditionally a standard 8-1/2x11 printed document, we believe this way of communicating technical information is more effective because the reader can

- (1) observe the actual evolution of dynamical processes,
- (2) choose the initial data and time-range of interest,
- (3) and visualize dynamics better through animation than by words.

The author wishes to thank Dansen Brown, Lt Bob Canfield, and Arnel Pacia (Chairman) for their conscientious review of this diskette.

Direct request for TR disk to:

Jon Lee, AFWAL/FIBG,
Wright-Patterson AFB, OH 45433.
Tel: (513) 255-5229.

HOW TO START

If you see two disk drives in front of the Z-100 desktop computer, then follow the procedure A. On the other hand, if you see only one disk drive, you probably have the Winchester disk system, so follow the procedure B.

Procedure A:

- (1) Insert the TR disk into the top drive (A drive).
- (2) Turn on the power switch (on the back).
- (3) After 30 seconds of the disk access light glowing and whirring, you will be presented with the screen like Figure 1.
- (4) Proceed at your own pace by responding to the prompt Press any key to continue. You will always return to the main menu (Figure 2).

Procedure B:

- (1) Insert the TR disk into the disk drive.
- (2) Turn on the power switch (on the back).
- (3) Press the [CTRL] and [RESET] keys simultaneously. Then, immediately, press the [DELETE] key, while the disk access light is still glowing. The screen will then display;

Boot Abort



- (4) Press the [B] key. The screen will display;
Boot
- (5) Then press [F1] key and [RETURN].
- (6) After 30 seconds of the disk access light glowing and whirring, you will be presented with the screen like Figure 1.
- (7) Proceed at your own pace by responding to the prompt Press any key to continue. You will always return to the main menu (Figure 2).

AFWAL TR 86-3014 presents ...

COUNTER - BALANCED PENDULUM

by Jon Lee

press any key to continue

Figure 1. Congratulations! You have correctly entered into the program disk. Proceed at your own pace by responding to the prompt "press any key to continue".


```

*****
*           Table of Contents           *
*                                     *
* (0)  Foreword                       *
* (1)  Abstract                       *
* (2)  Introduction                   *
* (3)  Problem Statement              *
* (4)  Demo Run for Initial Angle =.3 (3 min) *
* (5)  Do Your Own Integration (3 min and-up) *
* (6)  Theoretical Analyses (6 min)   *
* (7)  Conclusions                   *
* (8)  References                    *
* (9)  Enough is Enough -- Quit      - *
*****

```

Enter a number (0,1,...,9) to proceed;
or <BACKSPACE>-key to cancel.

Figure 2. This is the main menu in the form of Table of Contents. Note the run time estimates when applicable. Allow about 15 minutes for a casual viewing of the entire TR disk.

END

DATE

FILMED

3-88

DTIC